REMARKS

Applicant respectfully submits that entry of this §1.116 Request for Reconsideration is proper.

Claims 1, 3, 5, and 7-11 are currently pending in this application. Claims 12-17, which have been constructively withdrawn, are canceled without prejudice or disclaimer.

Notwithstanding any claim amendments of those amendments that may be made later during prosecution, Applicant's intent is to encompass equivalents of all claim elements. Reconsideration in view of the foregoing amendments and the following remarks is respectfully requested.

Claims 1, 7, and 9 stand rejected under 35 U.S.C. §103(a) as unpatentable over U.S. Patent No. 5,523,589 to Edmond et al. (hereinafter, Edmond) in view of U.S. Patent No. 6,072,189 to Duggan. Claims 3, 5, 8, 10, and 11 stand rejected under 35 U.S.C. §103(a) as unpatentable over Edmond in view of Duggan and further in view of U.S. Patent No. 6,258,617 to Nitta et al. (hereinafter, Nitta).

These rejections are respectfully traversed in view of the following discussion.

I. THE CLAIMED INVENTION

The claimed invention, as described in claim 1, is directed to a group III nitride compound semiconductor device of a successively laminated structure that comprises a substrate, a buffer layer formed directly on the substrate, an intervening layer formed directly on the buffer layer, the intervening layer comprising $In_XGa_{1-X}N$, where $0<X<1$, and a light-emitting layer formed directly on the intervening layer, the light-emitting layer comprising $In_YGa_{1-Y}N$, where $0<Y<1$, in which a first In composition ratio of the intervening layer, X, changes from a first interface with the buffer layer to a second interface with the light-emitting layer, such that, the first In composition ratio, X, at the second interface becomes substantially equal to a second In composition ratio, Y, of the light-emitting layer.

The claimed invention, as described in claim 3, is directed to a group III nitride compound semiconductor device of a successively laminated structure that comprises a substrate, a buffer layer formed directly on said substrate and having a buffer layer lattice

constant, an intervening layer formed directly on said buffer layer, said intervening layer comprising $Al_aGa_bIn_{1-a-b}N$, where $0<a<1$, $0<b<1$, and $a+b<1$, and a light-emitting layer formed directly on said intervening layer, said light-emitting layer comprising $In_YGa_{1-Y}N$, where $0<Y<1$, and having a light-emitting layer lattice constant, in which composition ratios of at least Al and In of said intervening layer change from a first interface with said buffer layer to a second interface with said light-emitting layer, such that, a first lattice constant of said intervening layer at said first interface is substantially equal to said buffer layer lattice constant and changes to a second lattice constant at said second interface, which is substantially equal to said light-emitting layer lattice constant.

II. THE PRIOR ART REJECTIONS

A. The Edmond Reference

Fig. 1 of Edmond discloses an LED 20 comprising a buffer layer 23 on the substrate 21 (col. 5, lines 18-19). The buffer layer 23 is selected from the group consisting of ternary Group III nitrides having the formula $A_xB_{1-x}N$, where A and B are Group III elements and where x is a fraction between zero and one (col. 5, lines 20-24).

Fig. 1 also discloses a double heterostructure 24 comprising an active layer 25 along with upper 26 and lower 27 heterostructure layers adjacent the active layer (col 5, lines 41-44). The heterostructure layers 26 and 27 are preferably formed of a composition selected from the group consisting of ternary Group III nitrides having the formula $A_xB_{1-x}N$, where A and B are Group III elements and where x is a fraction between zero and one (col. 5, lines 44-49).

In a third embodiment of the invention, the buffer layer comprises a first and second layers 47 and 48 respectively (col. 6, line 62 to col. 7, line 3). The first layer 47 is on the substrate 43 and is formed of a graded composition of silicon carbide aluminum gallium nitride $(SiC)_xAl_yGa_{1-y}N$ in which the portion adjacent the substrate 43 is substantially entirely silicon carbide and the portion furthest from the substrate is substantially entirely aluminum gallium nitride, with the portions therebetween being progressively graded in content from the predominantly silicon carbide to predominantly aluminum gallium nitride (col. 7, lines 3-11).

The second layer is on the first layer and is formed of another graded composition of aluminum gallium nitride (col. 7, lines 12-13). The composition of the graded second layer 48 is graded from a composition matching the composition of the first buffer layer 47 at the point where the layers 47 and 48 meet, to a composition matching the composition of the lowest layer of the double heterostructure 45 (col. 7, lines 14-19).

With respect to Fig. 3, the buffer layer can also be described as having at least one graded layer of silicon carbide and a Group III nitride in which the graded layer is silicon carbide at the interface with the substrate and then progressively graded to a composition matching the composition of the lowest layer of the double heterostructure at the interface with the double heterostructure (col. 7, lines 20-26).

The invention of Edmond can further comprise a strain-minimizing contact layer (not shown) above the active layer in the double heterostructure and that would have a lattice constant substantially the same as the respective buffer layers.

Claim 1 recites at least the features of "an intervening layer formed directly on said buffer layer, said intervening layer comprising $In_XGa_{1-X}N$, where $0<X<1$ ... wherein a first In composition ratio of said intervening layer, X, changes from a first interface with said buffer layer to a second interface with said light-emitting layer, such that, said first In composition ratio, X, at said second interface becomes substantially equal to a second In composition ratio, Y, of said light-emitting layer."

Similarly, claim 3 recites at least the features of "an intervening layer formed directly on said buffer layer, said intervening layer comprising $Al_aGa_bIn_{1-a-b}N$, where $0<a<1$, $0<b<1$, and $a+b<1$ ... wherein composition ratios of at least Al and In of said intervening layer change from a first interface with said buffer layer to a second interface with said light-emitting layer, such that, a first lattice constant of said intervening layer at said first interface is lattice-matched to said buffer layer and changes to a second lattice constant at said second interface, which is substantially equal to said light-emitting layer lattice constant."

Graded layers are obviously within the contemplation of Edmond at the time of his invention as evidenced by embodiments where the first and second layers, the buffer layer, and even a strain-minimizing contact layer (not shown) above the active layer in the double heterostructure. Edmond even realizes that graded layers may provide a strain-minimizing

contact between layers.

However, nowhere does Edmond teach or suggest a graded layer in contact between an active light-emitting layer and a buffer layer, which presumably may correspond to the either the lower layer of the double heterostructure or the buffer layer. In contrast, the present invention comprises a graded layer between the active light-emitting layer and the buffer layer, because the improved crystallinity (effected by better lattice-matching at the interface) of the InGaN active light-emitting layer improves the intensity if emitted light.

Moreover, the structure of the graded layer according to the invention is different from that of Edmond, which comprises SiC and AlGaN.

B. The Duggan Reference

Fig. 7 of Duggan is a schematic diagram of a light-emitting diode structure having the same constituent layers as the structure of Fig. 1, but with the introduction of graded layers 41, 42, 43 and 44 at the interfaces between the (AlGa)N cladding layers 4 and 6 and both the GaN contact layers 3 and 7 and the (InGa)N active layer 5 (col. 7, lines 55-61). Whilst graded layers 41, 42, 43, and 44 are shown at each of these four interfaces in the diagram of Fig. 7. it should be understood that it is also within the scope of the invention to provide graded layers 42 and 43 only at the interfaces between the (AlGa)N cladding layers 4 and 6 and the (InGa)N active layer 5 (col.5, lines 61-66).

Claim 1 recites at least the features of "an intervening layer formed directly on said buffer layer, said intervening layer comprising $In_xGa_{1-x}N$, where $0<X<1$ ... wherein a first In composition ratio of said intervening layer, X, changes from a first interface with said buffer layer to a second interface with said light-emitting layer, such that, said first In composition ratio, X, at said second interface becomes substantially equal to a second In composition ratio, Y, of said light-emitting layer."

Similarly, claim 3 recites at least the features of "an intervening layer formed directly on said buffer layer, said intervening layer comprising $Al_aGa_bIn_{1-a-b}N$, where $0<a<1$, $0<b<1$, and $a+b<1$ ... wherein composition ratios of at least Al and In of said intervening layer change from a first interface with said buffer layer to a second interface with said light-emitting layer, such that, a first lattice constant of said intervening layer at said first interface is lattice-

matched to said buffer layer and changes to a second lattice constant at said second interface, which is substantially equal to said light-emitting layer lattice constant."

Duggan discloses an (InGa)N active layer 5, presumably corresponding to the light-emitting layer of the present invention, an (AlGa)N cladding layer 4, and a graded layer 42, presumably corresponding to the intervening layer of the present invention, which must comprise an In composition ratio graduated between zero at the cladding layer 4 interface (since the cladding layer contains no In) and the In composition ratio of the (InGa)N active layer 5 at the (InGa)N active layer interface and an Al composition ratio graduated between the Al composition ratio of the (AlGa)N cladding layer 4 at the (AlGa)N cladding layer interface and zero at the active layer interface (since the active layer contains no Al).

In contrast, the graduated intervening layer of the present invention never has a zero In composition ratio, even at the buffer interface. Therefore, Duggan does not teach or suggest every feature of claims 1 and 3.

Furthermore, the graded layers of the present invention are disposed <u>beneath</u> the p-GaN layer. In Duggan, however, the p-AlGaN layer, which is disposed beneath the p-GaN layer, comprises a graded layer. Thus, the structure of the layers of the present invention is clearly distinguished over that of Duggan.

The Examiner cites Duggan to support the modification of Edmond by introducing graded layers. However, the Applicant respectfully submits that <u>nowhere does Edmond suggest the desirability of such a combination</u>, as required by *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). See, MPEP §2143.01.

The present invention describes at least the features of graded layers comprising InGaN or AlGaIn comprising graded composition ratios of In and Ga, and Al, Ga, and In, respectively. <u>Nowhere does Edmond disclose, teach or suggest the features of graded layers as defined by the claims of the present invention</u>.

In fact, <u>Edmond is obviously aware of the use of graded layers</u> in the fabrication of LEDs, since Edmond discloses embodiments where the first and second layers, the buffer layer, and even a strain-minimizing contact layer (not shown) above the active layer in the double heterostructure are graded. Thus, in view of all of the foregoing, there is no motivation to combine Edmond and Duggan. Furthermore, Applicant respectfully submits

that there would be no need to rely on the combination of Edmond and Duggan absent impermissible hindsight reconstruction.

Applicant respectively submits that nowhere does Edmond suggest the desirability of the Office Action's proposed modification of using a graded layer between the buffer layer and the light-emitting layer of the claimed invention, as required by *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). Therefore, Applicant further respectfully submits that the combination of Duggan with Edmond does not properly constitute a *prima facie* case of obviousness under 35 U.S.C. §103(a). Withdrawal of the rejection of claims 1, 7, and 9 under 35 U.S.C. §103(a) as unpatentable over Edmond in view of Duggan is respectfully solicited.

C. The Nitta Reference

The Examiner recites Nitta for teaching a blue light emitter where the active layer 104 can be InGaN and the clad layer can be InAlGaN and that the wavelength of the emitted light can be adjusted by varying the compound to provide sufficient optical confinement and to use a compound to increase the wavelength available (Final Action, page 3, item 8).

However, as is known to one of ordinary skill in the art, grading the In composition layer within the gallium-nitride-based n-type semiconductor clad layer 103 to form the n side of a pn junction that forms a light emitting region, would defeat Nitta's purpose of selecting a particular composition ratio of In for a corresponding selected wavelength of light.

The Examiner's proposed modification of Nitta by the graded layers of Duggan would render the invention of Nitta unsatisfactory for its intended purpose. Thus, there is no suggestion or motivation to make the Examiner's proposed modification. See, MPEP §2143.04.

In addition, as respectfully argued above, the proposed combination of Duggan with Edmond does not properly constitute a *prima facie* case of obviousness under 35 U.S.C. §103(a) because nowhere does Edmond suggest the desirability of such a combination, as required by *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). Likewise, nowhere does Nitta suggest the desirability of such a combination. Therefore, Applicant further respectfully submits that the combination of Duggan with Edmond and/or Nitta does not

properly constitute a *prima facie* case of obviousness under 35 U.S.C. §103(a).

Withdrawal of the rejection of claim 3 and claims 5, 6, 8, 10, and 11, which depend from claim 3, under 35 U.S.C. §103(a) as unpatentable over Edmond in view of Duggan and further in view of Nitta is respectfully solicited.

III. CONCLUSION

In view of the foregoing, Applicant submits that claims 1, 3, 5, and 7-11, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 4/20/04

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CERTIFICATION OF FACSIMILE TRANSMISSION

I hereby certify that I am filing this Amendment by facsimile with the United States Patent and Trademark Office to Examiner Douglas A. Wille, Group Art Unit 2814 at Official Facsimile Number (703) 872-9306 this 20th day of April, 2004.

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